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POLYCULTURE OF SIX FISH SPECIES UNDER DIFFERENT MANAGEMENT SYSTEMS IN EGYPT.

By

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ABSTRACT

A polyculture Combination of silver carp, Hypophthalmichthys molitirx; common carp, Cyprinus carpio, bighead carp; Aristichthys nobilis, grass carp, Ctenopharyngodon idella; mullet, Mugil cephalus and tilapia, Oreochromis niloticus at stocking densities of 1488, 1488, 571, 714, 2620 and 3119 fingerlings per hectar, respectively was examined through two successive durations of cultivation, namely short duration and long duration of 7 & 19 months respectively. In the short duration, the net production was 1851 kg/hectar and the food conversion ratio was estimated as 3.19. The net production for the long duration was 5050 kg/hectar and the food conversion ratio was found as 3.42.

On the other hand, fish production in the polyculture system using multiple harvesting technique was evaluated over the same above mentioned periods. The net production during the short term culture (7 months) was 1934 kg/ha at a survival rate of 94.8 % and a food conversion ratio of 3.05. While, it was 6498 kg/ha for the long term culture (19 months) at a survival rate of 89.5 % and a food conversion of 2.74.

Some fish species such as silver carp and common carp reached near the maximum carrying capacity in shorter time than that for the other fish species.

Intraspecific competition among large carps and their progeny from the wild spawning and interspecific competition between carps and mullet sharing the same ecological niche decreased the growth rate of common carp where natural food was not sufficient.

INTRODUCTION

Fish farms in Egypt whether public or private, cover an area of about 46250 hectars mostly in Delta, producing about 12 % of a total fish production. The average yields of these fish farms are low and variable, ranging from 1200 to 1700 kg/hectar often over a growing period approximated 18 months (world Bank document, 1981).

Different combinations of fish species in polyculture were used by authors of different countries according to specific conditions, as availability of fingerlings, adaptability of species to climatic conditions, market demand, types of food available and nature, of the pond (Pruginin, 1975; Ramaurthy et al., 1978; Dimitrov, 1984; Rabanal, 1985 & Falaya, 1986).

The present work provides an information on the polyculture system under different management systems in Egyptian fish ponds, the traditional and multiple harvesting technique through two successive periods of cultivation. This may help in planning and management of fish culture in Egypt.

MATERIALS AND METHODS

The period of this study is 19 months, started at April, 1988 and ended by November, 1989. The experimental ponds at the National Aquaculture Research Center (NASR) Abbassa-Sharkia Governorate, were used for this study. Rectangular ponds of 0.084 hectar each, with depth of 130 cm and slope of the bottom (1 % gentle slope toward the outlet) were supplied with fresh water from Ismaelia canal through El-Gadoon Canal. Two fine mesh screens were used for each pond to prevent wild fish. Water input in the ponds usually covers the losses from evaporation and seepage.

The polyculture system was composed of six species : Silver carp (*Hypophthalmichthys molitirx*), a phytoplanktophagic species; common carp (*Cyprinus carpio*), a benthophagic species; bighead carp (*Aristichthys nobilis*), a zooplanktonic species; grass carp (*Ctenophryngodon idella*) a macrophytophagic species; mullet (*Mugil cephalus*), a benthophagic species and Nile tilapia (*Oreochromis niloticus*), a detritophagic species.

Six ponds were stocked with the above mentioned fish species according to the following :

Species	No./Pond	No./Hectar	Stocking %
Silver carp	125	1488	15
Common carp	125	1488	15
Bighead carp	48	571	6
Grass carp	60	714	7
Mullet	220	2620	26
Nile tilapia	262	3119	31
Total	840	10000	100

Three ponds were used to examine the traditional polyculture technique, and the other ponds for the multiple harvesting experiment.

After seven months, the ponds were harvested and the data had been recorded, fish of each pond were returned back and the experiment continued for another 12 months. Consequently, the raising period is considered as two durations, short term culture (7 months) and long one (19 months).

During the short term growing period, three intermediate harvesting were carried out (August, 2; September, 23 and October 13, 1988) where as marketable size fish were harvested. Harvested fish were sorted into species, enumerated and individually weighed.

During the extended period, five intermediate harvestings were carried out (November 15, 1988; March 28, 1989; June 6, 1989; Augusr 5, 1989; and September 13, 1989). After each intermediate harvesting, ponds were restocked with fingerlings-held in storage ponds to compensate harvested fishes.

Artificial feed was offered based on body weight of fish. Feeding had been carried out equally once a day with cattle pellets of 12 % protein. Feeding rates were adjusted after each sampling that was linked to the intermediate harvestings.

Chemical fertilization was carried out four times throughout the study with total of 360 kg/ha of superphosphate and 190 kg/ha of Urea.

RESULTS AND DISCUSSION

A - Traditional Method : -

In table 1, fish production of was 1851 kg/ha in the short duration culture which extended seven months at survival rate of 95 % with 3.19 food conversion ratio. A total yield of 5232 kg/ha for the long duration (19 months) was obtained (Table 2) at survival rate of 90 % and a food conversion ratio 3.43.

The net production of short term experiment contributed 36.6 % of the long term one. Out of that (5051 kg/ha) silver carp comprised 1077 kg, common carp 1309 kg (the wild reproduction represented 27 %), bighead 158 kg, grass carp 111 kg, mullet 417 kg and tilapia 1979 kg (the wild reproduction represented about 67 %). The percentages of survival were 82.2; 90.4; 97.9; 96.7; 78.1 and 94.3 % for the above mentioned fish species, respectively.

Comparing the results of short and long term culture as presented in tables 1 and 2 demonstrates high net production of different fish species. The increase of 387, 666 (of which wild reproduction represented 53.6 %), 103, 94, 295 and 1654 (of which 80.2 % wild reproduction) was recorded for silver carp, common carp, bighead carp, grass carp, mullet and tilapia, respectively.

The growth rate of different fish species during the experimental period is presented in figure 1. The average individual weight of silver carp was 517 and 894 g/fish at the end of the short duration and the long one respectively, with an average weight gain of 71 and 46 g/fish/30 days respectively. This means that silver carp continued its growth in the long term culture at a lower rate than that of the short term one.

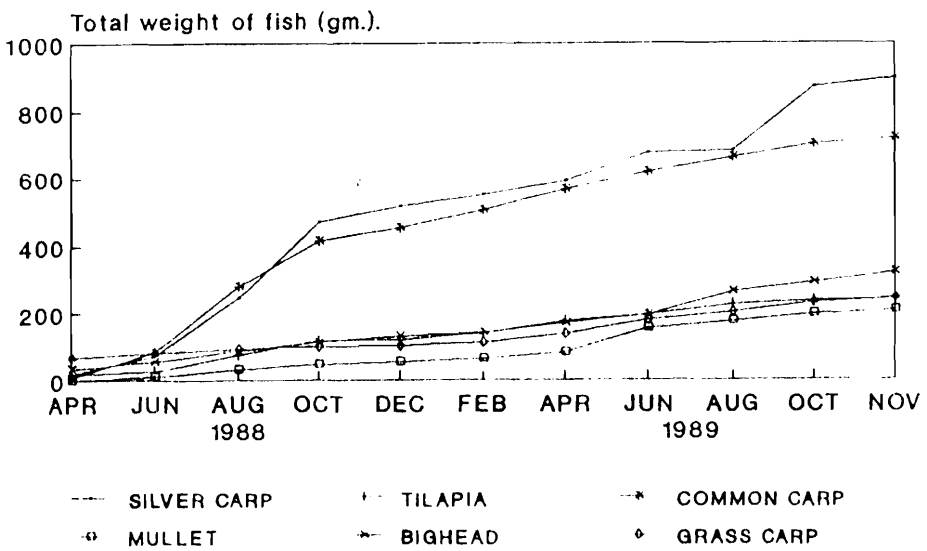

Figure 1: Growth rate of Different Fish Species in Tradional Experimental Fish Ponds Egypt.

Table 1: Proportions and survival rates of different species at the end of short-term culture (7 months) at the (NAC), Abbassa, Egypt.

Species	Initial stocking					Total production			Net production			Proportion net production %	Survival %	FCR
	No.per 840 m2	No. /ha	Ave.wt./ fish (g)	Kg per 840 m2	Kg/ha	Ave wt. /fish (g)	Kg per 840 m2	Kg/ha	Gain in wt /fish 30 days	Kg per 840 m2	Kg/ha			
Silver carp	125	1488	20	2.50	29.8	517.1	60.50	720.2	71.0	58.0	690.5	37.3	93.6	
Common carp	125	1488	7	0.88	10.5	453.5	54.88	653.3	63.8	54.0	242.9	34.7	96.8	
Bighead carp	48	571	34	1.63	19.4	130.0	6.23	74.2	13.7	4.6	54.8	3.0	100.0	
Grass carp	60	714	79	4.74	56.4	102.4	6.14	73.1	3.3	1.4	16.3	0.9	100.0	
Mullet	220	2620	2	0.44	5.2	55.4	10.64	126.7	7.63	10.2	121.4	6.6	87.3	
Tilapia	262	3119	19	4.98	59.3	118.9	30.78 * + 1.5	366.4 * +17.5	16.7	25.8 * +1.5	307.0 * +17.5	17.5	98.9	
Total	840	1000	-	12.67	180.6	-	108.67 * + 1.5	2013.9 * +17.5		154.0 * +1.5	1832.9 * +17.5	100.0	95.0	3.19

* :Tilapia reproduction
FCR :Feed conversion ratio

Table 2: Proportions and survival rates of different species at the end of long-term culture, (19 months) at the NAC, Abbassa, Egypt.

Species	Initial stocking					Total production			Net production			Proportions of net production %	Survival %	FCR
	No/ 840 m2	No. /ha	Ave. wt/ fish (g)	Kg/ 840 m2	Kg/ha	Ave/ wt/ fish (g)	Kg per 840 m2	Kg/ha	Gain in wt./fish /30 days	Kg per 840 m2	Kg/ha			
Silver carp	125	1488	20	2.50	29.8	894.3	93.20	1107.14	46.0	90.5	1077.4	21.3	83.2	
Common carp	125	1488	7	0.88	10.5	716.0	80.88 +30**	962.9 +357**	23.6	80.0 +30 *	952.4 +357**	25.9	90.4	
Bighead carp	48	571	34	1.63	19.4	318.0	14.93	177.7	15.0	13.3	158.3	3.1	97.9	
Grass carp	60	714	79	4.74	56.4	242.0	14.04	167.14	8.6	9.3	110.7	2.2	96.7	
Mullet	220	2620	2	0.44	5.2	206.0	35.44	421.9	10.7	35.0	416.7	8.3	78.1	
Tilapia	262	3119	19	4.98	59.3	241.6	59.68 * +111.5	710.5 * +1327.4	12.6	54.7 +111.	651.2 1327.4*	39.2	94.3	
Total	840	10000	-	15.1	180.6	-	297.97 ** +30 +111.5	3547.28 ** +357 +1327.4*		167. ** +30 +115*	3366.7 ** +357 +1327.4 *	100	90.1	3.43

* * :Common carp reproduction
* :Tilapia reproduction
FCR :Feed conversion ratio

The average individual weight of common carp at the end of short duration was 453 g/fish while it was 716 g/fish at the end of the long one with an average weight gain of 63.8 and 23.6 g/fish/30 days, respectively. which shows how the growth rate of common carp in the long term culture was much lower than that in the short one.

Similarly, the average individual weight of tilapia at the end of the short duration was 119 g/fish while was 242 g/fish at the end of the long one with an average weight gain of 16.7 and 12.6 g/fish/30 days, respectively; i.e. the growth rate of tilapia in the ling duration was lower.

On the other hand, the growth rate of bighead, grass carp and mullet was not similar to that of silver carp, common carp and tilapia. It was lower in the short duration, and higher in the long one.

The average weight of bighead carp at the end of the short term culture was 130 g/fish, whereas 318 g/fish at the end of the long one with an average weight gain of 96 g/fish and 284 g/fish (13.7 and 15 g/30 days), respectively.

The average fish weight of grass carp was 102 and 242 g/fish with an average weight gain of 3.3 and 8.6 g/fish/30 days at the end of the two durations.

Regarding the growth rate of mullet, it is clear that the average individual weight of mullet at the end of the short term culture was 55 g/fish while was 206 g/fish at the end of the long one with an average weight gain of 7.6 and 10.7 g/fish/30 days respectively.

However, the total average monthly weight gain for all the fish has been found to be almost the same in the short and the long cycles i.e. 265 kg/month/ha.

In table (3), the qualitative and quantitative evaluation of fish production . At the end of the short term culture, silver carp and common carp attained suitable marketable sizes but other fish species were not large enough. However, the production of the long duration, fish grades could be sorted as follows:

8.6 % of silver carp were more than 1000 g/fish while 89.5 % ranged from 501 to 1000 g/fish.

About 12.4 % of common carp (Initial stock) were more than 1000 g, 82.3 % ranged from 501 to 1000 g, while 3.5 % were from 401 to 500 g per individual. In addition, individual weight of all common carp reproduction ranged from 30-50 g/fish.

Bighead carp that had weight more than 400 g/fish represented 2.1 % of the whole number, 62.5 % (301-400 g) and 35.4 % (201 to 300 g).

Grass carp showed six different grades, 12.1 % out of the stock were more than 500 g/fish 10.3 % were (201 to 500 g) while 77.6 % were (100-200 g) per fish.

Mullet more than 500 g were 6.9 %, 5.8 % (301 to 500 g) while 87.3 % ranged from 101 to 300 g/fish.

Finally, 6.1 % of tilapia (original stock) exceeded 500 g, 13 % (301 to 500 g), 37.2 % (201 to 300 g) and 43.7 % (101 to 200 g) per fish. Out of that 45.9 % were 51-100 g per fish while, the rest (54.1 %) were less than 50 g.

Concerning the fish production of the polyculture, it was observed that in the short term culture, silver carp were faster in their growth and reached the maximum carrying capacity in a short time than other fish species. And larger fish require more amount of food in order to sustain is potential growth and maintain its body (Winberg, 1956), silver carp in the present study shows inverse performance in the long cycle. It continued its growth at a lower rate and reached an average weight of 517 and 844 g/fish during short and long term culture respectively> Inspite of the number of fish-food organisms available in

the ponds sufficient to maintain its body, however, it seemed that this in sufficient to allow further growth. This is probably due to the low temperature during winter included in the long duration, which could be a causative factor for dropping of the natural food (El-Serafy et al., 1991). The growth rate of silver carp in the long growing period was thereby reduced when the daily increment was 1.53 g/fish/day versus 2.37 g/fish/day versus 2.37 g/fish/day in the short term culture. Accordingly, silver carp represented the major fish component in the net production of the short growing period, as it contributed the highest percentage (nearly 37.3 %) of the total net production. Thus, high fish production can be obtained by cultivating fish species of planktonic feeding habits when short duration culture is considered. Similar result was obtained where Tilapia mossambica as a plankton feeder contributed the highest percentage of production in a combination with largemouth bass, channel catfish and blue gill of other feeding habits (Swingle, 1966). Generally, it has been proved from the present study that short duration is sufficient to yield a good production of silver carp inspite of the less average weight/fish.

In the present study it is noticed that common carp comes in the second rank after silver carp represents the second fish in the production of the short term culture 34.7 % (i.e. 643 kg/ha). Similarly, silver carp shows higher daily increment in the short duration (2.13 g/fish/day) and a slower growth rate during the long one (0.79 g/fish/day). This may be attributed to the competition between the progeny of the natural spawning and the large fish of the initial stock. The dense population of common carp results in stunting the fish population, hence the critical standing crop is reached at a lower fish weight and the growth rate is therefore reduced. This result contradicts the opinion that there is no competition between larger and smaller carp fish when grow in the same pond (Yashouv, 1969a). However, it is in partial agreement

Table 3: Qualitative and quantitative evaluation of fish production per 840 m² of traditional ponds at the end of short and long-term culture.

Species	Grade g/fish	short-term No.	short-term %	long-term No.	long-term %
Silver carp	200 - 300	4	3.4	-	-
	301 - 400	4	3.4	-	-
	401 - 500	9	7.7	2	1.9
	501 - 600	100	85.5	5	4.8
	601 - 700	-	-	16	15.4
	701 - 800	-	-	23	22.1
	801 - 900	-	-	32	30.8
	901 - 1000	-	-	17	16.4
	1001 - 1100	-	-	2	1.9
	1101 - 1200	-	-	2	1.9
	1201 - 1300	-	-	2	1.9
	1301 - 1400	-	-	3	2.9
Common carp	300 - 400	12	9.9	2	1.8
	401 - 500	109	90.1	4	3.5
	501 - 600	-	-	8	7.1
	601 - 700	-	-	22	19.4
	701 - 800	-	-	40	35.4
	801 - 900	-	-	15	13.3
	901 - 1000	-	-	8	7.1
	1001 - 1100	-	-	8	7.1
	1101 - 1200	-	-	6	5.3
Rep.	30 - 50	-	-	1010	100
Bighead carp	100 - 200	48	100	-	-
	201 - 300	-	-	17	35.4
	301 - 400	-	-	30	62.5
	401 - 500	-	-	1	2.1
Grass carp	100 - 200	60	100	45	77.6
	201 - 300	-	-	1	1.7
	301 - 400	-	-	2	3.4
	401 - 500	-	-	3	5.2
	501 - 600	-	-	2	3.4
	601 - 700	-	-	5	8.6
Mullet	50 - 100	192	100	-	-
	101 - 200	-	-	61	35.3
	201 - 300	-	-	90	52
	301 - 400	-	-	4	2.3
	401 - 500	-	-	6	3.5
	501 - 600	-	-	12	6.9
Tilapia	101 - 200	259	100	108	43.7
	201 - 300	-	-	92	37.2
	301 - 400	-	-	20	8.1
	401 - 500	-	-	12	49
	501 - 600	-	-	15	61
Rep.	3 - 7	100	100	-	-
	20 - 50	-	-	1365	54.1
	51 - 100	-	-	1160	45.9

with those found by Hepher and Pruginin (1981), who suggested an increase in density of common carp by 100 % results in decreasing the growth of 2000 carps (fed with Sorghum) by 26 % and by 24 % for the same stock (fed with pellets).

The present result agreement with that of Reich (1975) on "mixed nursing" of carp in pond cultivated with a combined population of 2000 large carps together with 3000 fingerlings/ha the daily increment of growth decreased by 38 % than that obtained from a pond cultivated with 2000 large carps. Further, the growth of common carp was inhibited during the long term culture probably due to the presence of Mugil cephalus in the same system. Yashouv (1972a) concluded that Mugil cephalus in a pond decreases yields of other fish. As a benthophagic feeder it compete with Cyprinus carpio which occupy the same ecological niche in the pond. Therefore, he recommended addition of Mugil capito which feeds mainly on plankton, to the polyculture instead of Mugil cephalus. Furthermore, the dense population of tilapia (due to reproduction) may have an interference with the slow growth of carp during the long term culture. Yashouv (1972b) found that the tilapia affect the growth of carp only when it is at large density and even then, the effect is slight.

Under the aforesaid circumstances, it is suspected that in order to obtain higher yields of common carp in such polyculture system in a short time, the wild spawning of tilapia should be avoided. The imbalance between carp and mullet should be adjusted.

The present study shows that Oreochromis niloticus is the most efficient species in the multi-species culture. Though the daily increment of the initial stock in the short term culture was higher than that in the long one (0.56 and 0.42 g/fish/day, respectively), yet there was a surpassing increase of the end yield of tilapia (2038 versus 384 kg/ha in the long and short terms, respectively), owing to the progeny of the natural reproduction that attained moderate sizes.

In the present study most of tilapia fry resulted from wild spawning attained the minimum weight of salable sizes. While, those of common carp did reach more than 30 g. Thus it can be inferred that the growth rate of tilapia is affected by stocking density to a lesser extent than that of carp and the intraspecific competition among tilapia even at high density is insignificant as observed by Yashouv (1969 a, b). This may indicate that the deficit in the natural food of tilapia population is supplementary feeding. While, smaller fish of common carp population may depend largely on the natural food. The same conclusion was reported by Yashouv (1969, 1972 b) when the density of Tilapia aurea increased by 354 % (without additional feed) decreases the growth only by 30 %.

The present study suggests that a fish pond could sustain much more greater quantity of tilapia than other fish species as growth rate of Oreochromis niloticus is not affected by the presence of others.

On the light of the present results, some procedures should be taken into consideration to regulate and improve the performance of tilapia in association with other fish species, so that a maximum yield of uniform marketable sizes could be obtained. The use of Oreochromis niloticus fry is recommended since they do not reproduce early in the rearing ponds and it is better to cultivate monosex tilapia (Pruginin, 1975).

The growth rate of Mugil cephalus seems to be low to the natural food deficiency in the ponds (El-Serafy et al., 1991). Meanwhile, it is a delicate fish and could not compete for the supplementary feed given, but pick up either the food particles floating on the surface or what is left from them on the bottom.

Unexpected low growth rate of bighead in the present study is noticed inspite of the availability of its requirements. It is difficult to explain its slow growth and a further study is needed. It is clear also that the growth rate of grass carp was higher in the long duration than that of the short one because green grasses which represents the main food item were not available during the early stages.

B - Multiple Harvesting :-

In multiple harvesting (the data in table 4). Silver carp contributed with 42 % of total fish production followed by common carp (27.7 %). Almost total production during that period came from the original stock except 24 kg/ha of tilapia reproduction were produced.

As presented in tables 4 and 6, 23.7 % of the total production during the short term culture was contributed to the three previously mentioned intermediate harvestings carried out in that period (510 kg/ha). Silver carp represented about 98 % of fish produced in such harvestings (499 kg/ha), while only 11 kg/ha were produced by common carp. However, because proportions of fish species in the final harvestings - upon drainage - varied than that in the intermediate harvestings considerably, the proportions of fish species diversified at the end of that period where only 42.2 % of marketable size fish were produced by silver carp followed by common carp 27.7, tilapia 17.6 %, mullet 5.2 % bighead 3.6 % and grass carp 3.7 %.

As for as the long term culture (19 months where growing season was extended for additional 12 months, and where five more intermediate harvestings took place, silver carp represented only 39 % of the total marketable size fish (Table 5). Other fish species contribute significantly in fish production as growing season advances. Even though, the contribution of the intermediate harvestings in the total production slightly increased during the extended period. However, there was a clear difference in fish proportions in such harvestings where contribution of silver carp was gradually declined while that for common carp increased.

Table 4: Total production, net production, fish proportions and survival rates during the short-term (7 months) at the (NAC), Abbassa, EGYPT.

Species	Stocking		Replacement		Total production(kg/ha)				Net production (kg/ha)				Survival %
	No.	Wt.	No.	Wt.	REP	MKT	Total	MKT %	REP	MKT	Total	MKT %	
Silver carp	1488	46.3	920	51.7	-	905.1	905.1	42.02	-	807.1	807.1	42.24	97.2
Common carp	1488	8.4	20	0.9	-	596.2	596.2	27.68	-	586.9	586.9	30.72	95.2
Bighead carp	571	19.1	-	-	-	78.6	78.6	3.65	-	59.5	59.5	3.11	96.4
Grass carp	714	56.5	-	-	-	80.3	80.3	3.73	-	23.8	23.8	1.25	97.6
Mullet	2620	3.5	-	-	-	113.0	113	5.25	-	109.5	109.5	5.74	87.0
Tilapia	3119	56.7	-	-	24.0	380.3	404.3	17.66	24	323.6	347.6	16.94	95.4
Total	10000	190.5	940	52.6	24.0	2153.5	2177.5	100.00	24	1910.4	1934.4	100.00	94.7

REP. : Reproduction
MKT : Marketable size

Table 5: Total production, net production, fish proportions and survival rates during the long-term (19 months) at the (NAC) Abbassa, EGYPT.

Species	Stocking		Replacement		Total production(kg/ha)				Net production (kg/ha)				Survival %
	No.	Wt.	No.	Wt.	REP	MKT	Total	MKT %	REP	MKT	Total	MKT %	
Silver carp	1488	46.3	1861	150.6	-	1986.2	1986.2	39.0	-	1789.3	1789.3	37.8	79.9
Common carp	1488	8.4	44	0.9	167	1151.8	1318.8	22.6	167	1142.5	1309.5	24.2	95.9
Bighead carp	571	19.1	210	18.5	-	372.1	372.1	7.3	-	334.5	334.5	7.1	96.3
Grass carp	714	56.5	103	4.3	-	228.7	228.7	4.5	-	167.9	167.9	3.6	94.8
Mullet	2620	3.5	60	3.3	-	493.7	493.7	9.7	-	486.9	486.9	10.3	78.8
Tilapia	3119	56.7	0	0	1607	859.2	2466.2	16.9	1607	802.5	2409.5	17.0	91.5
Total	10000	190.5	2278	177.6	1774	5091.7	6865.7	100.00	1774	4723.6	6497.6	100.00	89.5

REP. : Reproduction
MKT : Marketable size

Overall intermediate harvestings provided a total of 1810 kg/ha over the while growing period (19 months) where 59.2 % of which were silver carp, 23.1 % common carp, 9.1 % bighead carp, 4.6 % grass carp while, tilapia and mullet came last and were represented by 2.9 % and 1.1 %, respectively.

Fish composition of the eight intermediate harvestings carried out during the whole term varied significantly from that of the final harvestings. For example, silver carp represented only 28 % of the final harvestings compared to 59.2 % during the intermediate harvestings. On the other hand, marketable size tilapia and mullet were represented by 24.1 % and 14.5 % respectively in the final harvestings compared to 2.9 % and 1.1 % during the intermediate harvestings.

Also, it was found that seins suitable to retain marketable size of mullet or grass carp (selender fish) will also retain sub-marketable sizes of tilapia, silver carp, bighead carp and common carp (deep-bodied fish).

In table 5, the net production of the marketable size fish for the whole study was 4724 kg/ha at a survival rate 89.5 % that in addition to 1774 kg/ha of reproduction (tilapia 1607 kg; common carp 167 kg).

It is expected that intermediate harvestings would not have appreciable role in increasing fish production as long as fish are still under the limit of the critical standing crop as in the short growing period. The absolute increase in weight of the large fish in this case would be higher than the relative growth rates of the replaced fingerlings. But with the extending of rearing period, situation would differ where fish then reach near the critical standing crop as noticed with silver carp and common carp in the traditional polyculture system where the growth rates began to slacken gradually, up to a limit at which it would be better to be partially removed and replaced. These fingerglings and the remaining fish would have more space and food (as it has been implied by the hydro-biological analysis of the ponds) (El-Serafy et al., 1991). Also their relative growth rates in this case would be higher. This indicates that practicing the multiple harvesting technique would be more beneficial compared to traditional systems as durations of growing period increase.

The present data contradict the results of Ramakrishna et al., (1982) where they concluded that short-terms brackish-water culture with repeated harvests is more desirable than that in the prolonged one. Such discrepancy may be attributed to the ecological and climatological conditions.

The final harvesting of the multiple harvested ponds and the single harvest of the traditional ponds at the end of the two durations of culture may support this explanation. The former was lower by 365 kg/ha (2032-1667) than that in the traditional ponds at the end of the short term culture, while that difference was reduced to 176 kg/ha (5232-5055) at the end of the whole study.

Table 6: Total fish production and proportions of species through the intermediate harvesting during the short-term (7 months) and

Species	Short-term			Long-term		
	No.	Weight	%	No.	Weight	%
Silver carp	920	499.0	97.8	1861	1072.0	59.2
Common carp	20	11.3	2.2	496	417.5	23.1
Bighead carp	-	-	-	210	164.2	9.1
Grass carp	-	-	-	103	83.9	4.6
Mullet	-	-	-	60	19.4	1.1
Tilapia	-	-	-	206	53.2	2.9
Total	940	510.3	100	2936	1810.2	100.0

Paessun and Allison (1984) worked on maximizing tilapia production, concluded that sequential rearing technique is practical in a " production flow" system when fish are added continually into the scheme as fingerlings and harvested as marketable fish of uniform sizes. It would be a prerequisite then to nurse the fry first in separate ponds.

Multiple harvesting technique employed in the present study provided a better use of production inputs specially water resources in addition to the ability of marketing fish over the whole year. However, modification may be applied follow-up studies in regards to stocking rates, standards of marketable sizes, species combinations and management practices that suit different production systems.

REFERENCES

Dimitrov, M., 1984. Intensive polyculture of common carp (Cyprinus carpio), herbivorous fish silver carp (Hypophthalmichthys molitrix) and Grass carp (Ctinopharyngodon idella). Aquaculture, 38: 241-253.

El-Gamal, A.A., 1992. Predation by Nile Perch Lates niloticus (L.) on Oreochromis niloticus (L.) Cyprinus carpio (L.), Mugil sp. and its role in controlling tilapia recruitment in Egypt, J. Fish. Biol., 40: 351-358.

El-Serafy, S.S., Al-Zahaby, A.A., El-Gamal, A.A., and Abd El-Nasser, G., 1991. Plankton in traditional and improved technique of fish culture. Egypt, J. Appl. Sci., 6 (10): 429-440.

Falaya, A.E., 1986. Fisheries management under polyculture in tropical freshwater ponds. J. West AFR. Fish., 1 (1): 47-54.

Hepher, B., and Pruginin, Y., 1981. Commercial fish farming with special reference to fish in Israel. John Wiley and sons, New York, pp. 261.

Paessun, M.A., and Allison, R., 1984. Maximizing tilapia production in recirculating systems by sequential rearing. Aquaculture, 42: 185-189.

Pruginin, Y., 1975. Species Combination and stock densities in aquaculture in Africa. J. Announcement 8104 FAO/UNDP.

Rabanal, H.R., 1985. Stock manipulation and other biological methods of increasing production of fish through pond fish culture in Asia and Far East. FOA world Symp. on warm-water pond fish culture. Rome, Italy, 4 (44): 276-287.

Ramakrishna, K.V.; Ramamohanno, G.R.; Prassadm, R.D.; Raman, K; Kadir, R.M.A.; Krishnan, S. and Joseph, K.O., 1982. Observations on the mixed culture of brackish water fishes and prawns in a pond at Adyar, Madras. Proc. Symp. Costa Aquaculture, 1: 244-250.